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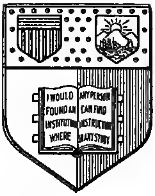
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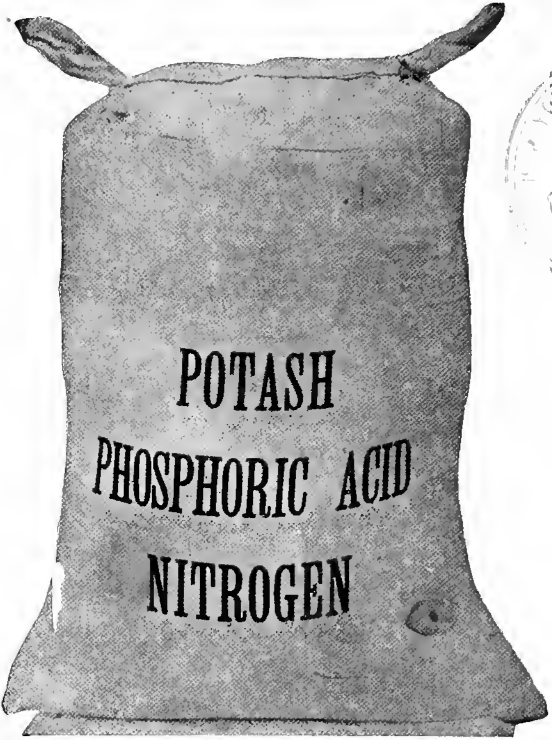

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FERTILIZER GUIDE

FOR

THE WEST INDIES

PUBLISHED BY
GERMAN KALI WORKS
HAVANA, CUBA
PORT OF SPAIN, TRINIDAD

This pamphlet as well as the following may be obtained free of charge by writing to:

GERMAN KALI WORKS,

P. O. BOX 1007, 30 EMPEDRADO, HAVANA, CUBA.	OR	NO. 2 ST. VINCENT ST., PORT OF SPAIN, TRINIDAD, B. W. I.

BANANAS IN THE WEST INDIES.

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MISCELLANEOUS ECONOMIC PLANTS IN THE WEST INDIES.

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All of the above can be obtained in Spanish if desired. Those marked with "X" can also be obtained in French.

PLANT FOOD.

PLANT food is any substance which helps to nourish the plant, and although there are a great many of the elements necessary, nearly all soils contain enough for ordinary plant growth except of Potash, Phosphoric Acid and Nitrogen. Therefore when speaking of plant food, only these three are considered. While most soils contain some of each of these elements, we often find that they are present in an unavailable form and are therefore of but little value to the plants. For instance many such as muck soils, contain large amounts of nitrogen, but in order to produce a crop of vegetables, it is usually necessary to apply nitrogen in a quickly available form, showing that they are not able to utilize that of the soil. Clay soils are usually supposed to contain potash, and they often do, but it is generally in such a form that it cannot be utilized by the plants.

Many soils also contain an overabundance of phosphoric acid, but it must be dissolved in strong acids to make it available. We therefore see that although a chemical analysis may show that the soil contains an abundance of plant food it may be practically poor because the plants do not exude acids strong enough to dissolve them.

HOW PLANTS FEED.

The three above named plant foods, in which we are especially interested, are all absorbed by the roots in solution. That is to say, the material in which the plant food occurs, must be soluble in water, or at least in the weak acids exuded by the plant roots. While the three elements, nitrogen, potash and phosphoric acid, together with other elements with which we are not concerned, are all plant foods, we find that plants cannot grow and feed upon any one, or any number of them if they are not all present. This is a very important fact to bear in mind, because a soil may contain an abundance of nitrogen for instance, and fail to produce a crop on account of being short of potash or phosphoric acid.

Furthermore, many plants are as exacting in their food requirements as animals or people, which is clearly shown, with tobacco, for instance, where a change of fertilizer will make a great difference in the quality of the leaf. In oranges, an overabundance of nitrogen will cause various derangements in the tree and will cause the fruit to be soft, puffy and insipid, all of which can be rectified with an application of potash.

FERTILIZERS.

A fertilizer is a mixture of materials containing one, two or all three of the plant food elements nitrogen, phosphoric acid and potash, and is valuable according to the amount contained and the form in which they are present.

A fertilizer may be made by any planter, but usually it is bought ready made and in either case it is necessary for the planter to know what and how much plant food it contains, to judge if it is what his crop needs and if the cost is reasonable.

WHAT DOES THIS SACK CONTAIN?

The formula printed on this sack may with more or less modification and change of figures be found on the average sack of fertilizer sold in the West Indies, and of this we want to know, not alone how much there is but also how much of it is soluble.

We here have first ammonia 5 per cent. What is ammonia? It is a chemical combination of the elements nitrogen and hydrogen, of which nitrogen alone is of interest to the planter, as hydrogen is not a plant food that needs to be applied, we are therefore not interested in ammonia but in nitrogen.

Next we have nitrogen 4.11 per cent, which is the same thing stated over again, as 5 per cent ammonia is equal to 4.11 per cent nitrogen and it means that there are 4.11 pounds of pure nitrogen in every 100 pounds of the fertilizer or 41.1 per 1,000 pounds, or 82.2 pounds per ton.

We next find bone phosphate of lime 19.64 per cent, which would imply that the phosphoric acid was derived from bone, but as there is, as shown in the fifth item, 6 per cent soluble, we know that the bone has been treated with sulphuric acid and that the phosphoric acid is therefore in the form of acid phosphate, and as there is no practical difference between the acid phosphate from bone and from rock, the statement bone phosphate is of no value.

We next have the item phosphoric acid 9 per cent, this we can also dispense with as we are interested in knowing only how much of this is available. It states soluble 6 per cent, which means that there are 6 pounds of readily soluble phosphoric acid in every 100 pounds of the fertilizer, or 120 pounds in every ton. It also states that there is 2 per cent reverted or citrate soluble, which means 40 pounds per ton of phosphoric acid, that is more slowly available. Next we have available 8 per cent, which is simply stating the matter over again, as both the 6 pounds and the 2 pounds are available. The next item insoluble, denotes the amount which is very slowly available to the average cultivated plant.

The next item is potash (K_2O) 10 per cent. The K_2O is the chemical abbreviation for potassium oxide, and simply denotes that there is 10 per cent or 10 pounds to the 100 pounds or 200 pounds to the ton, of potash in this fertilizer. The next item, equal to sulphate of potash 20 per cent, may imply that the potash is present in the form of sulphate and that it was derived from the 50 per cent grade, but it is no guaranty. The above formula would be clearer if stated as follows:

Nitrogen Soluble -	2.	per cent.
Nitrogen Insoluble	2.11	"
Phosphoric Acid Assimilable	8.	"
Phosphoric Acid Insoluble	1.	"
Potash -	10.	"
Chlorine Maximum	.5	"

We here have the amounts of the nitrogen, phosphoric acid and potash and the conditions in which they are present.

Nitrogen, phosphoric acid and potash are the only three plant food elements that the planter needs to buy, and they are valuable to him according to their availability. In order to be available they must be soluble, and one that is soluble in water is readily available or assimilable, while one that requires a weak acid to dissolve it is slowly available, and one that requires strong acids is termed insoluble, which does not necessarily mean that it is unavailable, but that it is very slowly available, and of no immediate benefit to the average cultivated plant.

In referring to what the sack contained, we have 4.11 per cent nitrogen, 9 per cent total phosphoric acid and 10 per cent potash; altogether 23.11 per cent or 23.11 pounds per 100 pounds of the whole mixture, or 462.2 pounds per ton. But, what is the remaining 1537.8 pounds of the mixture? In order to understand this we will have to examine some of the materials furnishing nitrogen, phosphoric acid and potash. These elements are never found except in combination with other elements and it is therefore necessary to use large amounts of the combination in order to furnish the few pounds called for.

MATERIALS FURNISHING NITROGEN.

NITRATE OF SODA.

This is a more or less colorless salt found in South America from where it is exported and used in mixed fertilizers. It is readily soluble in water, and contains 14 to 16 per cent nitrogen, all of which is available (immediately after it is applied). As it contains only 14 to 16 per cent nitrogen, we see that we would have to use 100 pounds of it in order to get 14 to 16 pounds of nitrogen.

SULPHATE OF AMMONIA.

This is another substance furnishing nitrogen, and one which is much used in the West Indies. It is a by-product of the manufacture of gas, and usually 100 pounds of it contains 20 pounds nitrogen. It is a fine grained salt, varying in color from light green to dark blue. It is readily soluble in water and the nitrogen in it is readily available.

While nitrate of soda and sulphate of ammonia have until recently been the only inorganic sources of nitrogen, there is now on the market also nitrate of lime.

NITRATE OF LIME.

This is a manufactured product, the free nitrogen of the air being transformed into nitric acid by electricity and combined with lime. There are several products on the market, such as lime nitrogen, nitrolim, cyanamide etc. containing varying percentage of nitrogen. These materials have all been tried in the West Indies, but the available data is not conclusive. Those who contemplate buying should carefully try on a small scale before ordering large quantities. And if one kind fail, all of the products should not necessarily be condemned, for they are quite distinct one from another.

SLAUGHTER HOUSE PRODUCTS.

A great deal of the nitrogen in mixed fertilizers, is in organic materials, such as dried blood and tankage. These materials are waste products from the slaughter house, ranging in nitrogen content from 10 to 14 per cent as dried blood or 5 to 10 per cent as in the various combinations of tankage, and even as low as 0.5 per cent, as in some bone meals. The nitrogen in these products is much more slowly available than in the inorganic salts, which is of advantage under certain conditions, while under other conditions it may be wholly unsuitable.

FISH SCRAP.

This is seemingly of no great importance for the West Indies as it is not commonly used in fertilizers sold here, but it is actually of great value, as in a dried state it may contain over 10 per cent nitrogen. It is especially mentioned here to call attention to the fact, as there are many places in the West Indies where fish that are no good for food can be caught and utilized for fertilizers.

COTTON SEED MEAL, CASTOR POMACE AND OTHER PRODUCTS.

All seeds which yield oil contain considerable nitrogen, and the pulp of such seeds, after the oil has been extracted, is usually sold for cattle food or for fertilizer. Of these, cotton seed meal, containing 6 to 8 per cent nitrogen, is obtained in great quantities. Castor pomace, the meal of the castor bean, which contains 5 to 6 per cent nitrogen, is also valuable. Many of the tropical seeds and waste products can also be utilized for fertilizers, among them may be mentioned coffee pulp and tobacco stems.

GUANOS.

Of these there are many, and they all vary according to their source and place from which they are collected. One of the best known guanos is the Peruvian guano, which contains 6 to 10 per cent nitrogen. This is a deposit of bird dung which has accumulated through centuries in places where there has not been enough rainfall to wash it away. Most of the nitrogen in these guanos is readily available as is also the phosphoric acid of which they contain 7 to 8 per cent. These guanos contain practically no potash. Bat guano is another article of considerable interest in many places in the West Indies, where it occurs in caves, as deposits of bat dung. It is valuable according to the condition of the cave. If the cave is dry, and has always been dry, the deposit is usully rich in nitrogen, as well as available phosphoric acid. If on the other hand water has seeped through for many years, the nitrogen content is small and the phosphoric acid will be more or less insoluble. The potash content is usually nil.

MATERIALS FURNISHING PHOSPHORIC ACID.

The three principal sources of this substance are bone, obtained from the slaughter houses, phosphatic rock, and basic slag or Thomas slag. In the first two of these forms, the chemical combination of phosphoric acid and lime is not soluble in water and very slowly soluble in weak acids. In order to make the phosphoric acid assimilable, the material is ground very fine and then mixed with sulphuric acid, which changes the chemical composition, making nearly all of the phosphoric acid readily available to the average plant; the material so treated is called acid phosphate or superphosphate. The process is not always complete, however, and some of the phosphate remains insoluble; furthermore, on standing a long time, a gradual change takes place, and some of the phosphoric acid becomes less soluble than it originally was, which is called reverting. Hence the terms soluble, reverted, citrate soluble etc. But all that is of practical importance to the planter is to know how much available or assimilable phosphoric acid his fertilizer contains, which includes soluble and reverted. The average grade of superphosphate usually contains 13 to 16 per cent available phosphoric acid. Double acid phosphate contains 40 to 44 per per cent. Another grade contains about 30 per cent. Therefore, when buying it is necessary to ascertain the grade.

RAW GROUND BONE.

While rock phosphate is usually, and bone is very often treated with sulphuric acid, the latter is also used in fertilizers without such treatment. It has been found of late years, that if bone is ground very fine and steamed until it becomes flocculent, most plants are able to utilize it although it is not water soluble. Therefore raw ground bone, bone meal and tankage, must be judged not alone by the actual phosphoric acid contained, but also by the physical condition of the material.

BAT GUANO.

This material, which was described under nitrogen, often contains but very little nitrogen, while it may contain as much as 10 per cent or more of phosphoric acid. Of this there is seldom a great deal water soluble, but if it is in powder form, it may be available to most plants, although its action is naturally slower than that of acid phosphate.

THOMAS SLAG OR BASIC SLAG.

This is a by-product from iron smelters where the phosphoric acid contained in the iron ore is liberated and combined with lime. It is a valuable material for fertilizers as it usually contains about 20 per cent phosphoric acid, all of which is readily available.

MATERIALS FURNISHING POTASH.

The source of this plant food is limited almost entirely to the supply from the mines of the German Kali Works, located near the Harz Mountains in Germany. The potash salts from there are absolutely guaranteed to contain certain percentages of pure potash, all of which is readily soluble.

Potash salts are of two distinct combinations viz. muriate and sulphate. Both are equally valuable as far as the potash is concerned, but there are certain plants such as tobacco, which are injured by chlorine and the muriate can therefore not be used on them. Starch producing crops are also supposed to be injured by chlorides.

Of the muriatic forms we have **Kainit** which contains 12.4 per cent potash and **Muriate of Potash** providing 50 to 56 per cent pure potash.

Of sulphates we have **Sulphate of Potash-Magnesia,** which contains 27 per cent potash, and **Sulphate of Potash** containing 48 to 52 per cent. The high grade sulphate of potash is practically free from chlorine and is well suited for all crops including tobacco.

HOW A FERTILIZER IS MADE.

Again referring to what the sack contains and why it contains only 23.11 pounds of plant foods in every 100 pounds of the mixture, it may be well to state some examples.

Supposing the following materials are at our disposition:

Nitrate of Soda containing 15% Nitrogen.
Tankage { containing 8% Nitrogen.
" 8% Assimilable Phosphoric Acid.
" 2% Insoluble " "
Acid Phosphate containing 15% Assimilable " "
Sulphate of Potash " 50% Potash.

The mixture that we want requires:

Nitrogen Soluble	2.%	or 40 lbs.	per ton.
" Insoluble	- 2.11%	or 42 lbs.	"
Phosphoric Acid Assimilable	8.%	or 160 lbs.	"
Insoluble	1.%	or 20 lbs.	"
Potash	10.%	or 200 lbs.	"
Chlorine Maximum	.5.%.		

As one hundred pounds of nitrate of Soda contains 15 pounds nitrogen it will naturally require 266 pounds of this to supply 40 pounds of water soluble nitrogen. As the tankage contains 8 pounds of nitrogen per hundred, it will require 525 pounds of this to supply the 42 pounds of water insoluble nitrogen. The same 525 pounds would also supply 42 pounds assimilable phosphoric acid together with the 20 pounds insoluble which the formula calls for. Of acid phosphate, 100 pounds contains 15 pounds phosphoric acid, and it would therefore require 785 pounds to supply 118 pounds of assimilable phosphoric acid which together with the 42 pounds furnished by the tankage makes 160 pounds, as the formula calls for. As 100 pounds sulphate of potash contains 50 pounds of pure potash, it will naturally require only 400 pounds of this to supply the potash needed, and the statement, Chlorine maximum .5 per cent would be a guaranty that the potash was in the form of sulphate, and also that the other ingredients contained only a trace of chlorine. We then have a mixture as follows:

Nitrate of Soda	266 pounds.
Tankage	525 "
Acid Phosphate	785 "
Sulphate of Potash	400 "
	1976 pounds.

We therefore see that in order to supply 40 pounds of nitrogen from the nitrate of soda, we must apply 226 pounds of soda, which is not a direct plant food, but it cannot be avoided as pure nitrogen cannot be used. The same is true of the other elements. The tankage supplies 420 pounds of practically useless material, the acid phosphate, 667 pounds of lime and sulphate of lime. And the potash 200 pounds of sulphur trioxide.

As the mixture calls for a ton of 2,000 pounds, we will have to add 24 pounds of some inert material to make up the deficiency in weight. This make-weight or "filler" has always been a source of misunderstanding, the planter insisting, that he does not want to pay for, nor pay freight on, material that is of no use to him. But there are two sides to this question. The manufacturer might have made the above fertilizer as follows:

410 lbs. Sulphate of Ammonia (containing 20% Nitrogen)=82 lbs. Nitrogen.
1066 lbs. Acid Phosphate (containing 15% Phosphoric Acid)=160 lbs. Phosphoric Acid.
400 lbs. High Grade Sulphate of Potash (containing 50% Potash)= 200 lbs. Potash.
124 lbs. Filler.
2000 lbs.

This contains exactly the same amount of plant food as the former and it is an extremely high grade fertilizer, because all the plant food is readily soluble, and although it contains 100 pounds more filler than the other, no one would contend that it is not as valuable. As a matter of fact, the fertilizer containing filler is usually more valuable than the one, with the same plant food contents but without filler, because in the first instance, high grade materials alone are used, while in the last instance, low grades are used.

In using another example for illustration let us take a ferlilizer well known to fruit and vegetable growers contains 2 per cent nitrogen, 10 per cent potash and 5 per cent phosphoric acid, that is, a ton contains 40 pounds nitrogen, 200 pounds potash and 100 pounds phosphoric acid. This could be made as follows:

266 lbs. Nitrate of Soda (containing 15% Nitrogen)=40 lbs. Nitrogen.
400 lbs. Sulphate of Potash (containing 50% Potash)=200 lbs Potash.
666 lbs. Acid Phosphate (containing 15% Phosphoric Acid)=100 lbs. Phosphoric Acid.
————
1332 lbs.

We see that this 1332 pounds contains exactly the same amount of plant food as the ton with formula 2-10-5, and there is no reason why the 1332 pounds should not be applied to the same size field as the 2,000 pounds.

This fertilizer might also have been made as follows:

575 lbs. Cotton Seed Meal containing
- 7% Nitrogen=40 lbs. Nitrogen
- 1.1% Potash= 6 lbs. Potash.
- 2.% Phosphoric Acid=12 lbs. Phosphoric Acid.

1550 lbs. Kainit containing 12.5% Potash=194 lbs. Potash.
585 lbs. Acid Phosphate containing 15% Phosphoric Acid = 88 lbs. Phosphoric Acid.
————
2710 lbs.

We find here that it requires 2710 pounds to furnish 40 pounds of nitrogen, 200 pounds of potash and 100 pounds of phosphoric acid, and we would therefore have to apply 2710 pounds of this in order to equal the amounts of plant food furnished by the 1332 pounds in the former instance.

The only way in which the planter can overcome paying for freight and handling of useless materials, is by buying high grade fertilizers containing high percentages of plant food, or by buying high grade materials and mixing them.

THE UNIT BASIS.

Fertilizers are frequently sold on the unit basis. A unit is one per cent, therefore a fertilizer said to contain 4 units, of nitrogen for instance, contains as a matter of fact 4 per cent. That is 4 lbs. of nitrogen in every 100 lbs. of mixture, of 40 lbs. in 1000 lbs. or 80 lbs. in a ton. If that nitrogen was quoted at $4.00 per unit it would mean $4.00 for each 20 lbs. contained in the mixture, at 20 cents per pound.

MIXING.

As all of the materials previously mentioned are dry powders it is not difficult to mix them. The two essential points are: to rightly calculate the proportions, and to make an even mixture, free from lumps.

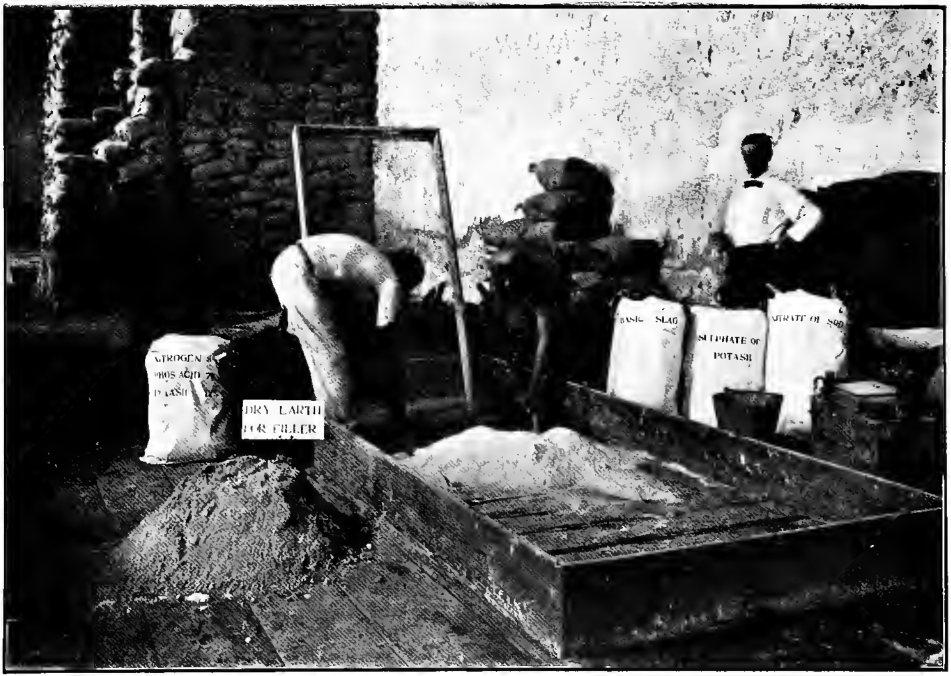
It is well to observe the following rules:

(1) Mix no more at one time than will be needed for the next 2 to 3 days.

(2) Lime and wood ashes should not be used in fertilizer mixtures.

(3) Basic slag should not be mixed with acid phosphate, nor with sulphate of ammonia, dried blood, yard manure or any other organic material.

(4) Acid phosphate and nitrate of soda should not be mixed together except when perfectly dry or when a lot of dry filler is used.



MIXING FERTILIZER ON THE PLANTATION.

(5) It is advisable, in all cases, to use plenty of dry filler. This prevents the mixture from caking, after prolonged exposure to dampness. It also insures a much more even distribution over the soil, especially when the application is small.

HOW TO MIX.

No special appliances are needed for mixing. The writer has mixed many tons in the body of an ordinary farm-wagon. All the essentials are: a hard, smooth floor, scales for weighing a hand screen or a masons sand screen, a tamper to break up the lumps and one or two shovels.

After having calculated how much will be needed of each ingredient including the filler, weigh off the necessary amounts and spread in alternate layers on the floor. In mixing large quantities no weighing is necessary, for each sack contains a certain known quantity which will be correct enough for calculation. If the materials at hand are acid phosphate, sulphate of potash and nitrate of soda, simply empty off a sack of acid phosphate, on the top of that a sack of nitrate of soda and the potash on top of that. Again in continuing, add sack by sack, alternately, of the different ingredients together with the necessary filler, and when the pile contains one to two tons, shovel it over, back and forth two to three times. After that screen it and pulverize the lumps. This pulverized material should again be screened onto the pile, after which the whole mass should be further mixed by shoveling back and forth once or twice more. The entire cost of such operation will not amount to more than 50 cents per ton, and that usually includes the cost of bringing in sand or dry earth for filler.

HOW TO CALCULATE A MIXTURE.

If it is known how many pounds of each ingredient it takes to supply 1 pound of potash, phosphoric acid, or nitrogen the calculation is easy. The following figures will be helpful.

For	1	lb.	Potash	needed	take	2	lbs.	Muriate or Sulphate of Potash
“	1	“	“	“	“	8½	“	Kainit
“	1	“	Phosphoric Acid		“	6¾	“	Acid Phosphate 15%
“	1	“	“	“	“	2½	“	Double Acid Phosphate 40%
“	1	“	“	“	“	5	“	Basic Slag
“	1	“	Nitrogen		“	6¼	“	Nitrate of Soda 16%
“	1	“	“	“	“	7⅐	“	Dried Blood 14%
“	1	“	“	“	“	5	“	Sulphate of Ammonia 20%

METHOD OF CALCULATION.

When the Weights of Potash, Phosphoric Acid and Nitrogen Are Known.

Example—Wanted 1000 lbs. of a mixture containing 80 lbs. potash, 50 lbs. phosphoric acid and 40 lbs. nitrogen, made from sulphate of potash, basic slag and nitrate of of soda. Use the figures given above; for each pound of potash wanted take two pounds of sulphate of potash. For each pound of phosphoric acid wanted take 5 pounds of basic slag etc.

Potash	80x2	equal	160	lbs.	Sulphate of Potash
Phosphoric Acid	50x5	“	250	“	Basic Slag
Nitrogen	40x6¼	“	250	“	Nitrate of Soda
			340	“	Filler
			1000	lbs.	

CALCULATION WHEN THE PERCENTAGE IS KNOWN.

Percentage in a mixture means the number of pounds of pure chemicals in 100 lbs. of mixture. Therefore the per cent multiplied by the number of hundred pounds in the mixture gives the weight in pounds of the potash, phosphoric acid and nitrogen.

Example—Wanted 1500 lbs. of a mixture containing 3% nitrogen 6% phosphoric acid and 9% potash. (Made from sulphate of ammonia, double acid phosphate and muriate of potash.

15x3	equal	45	lbs.	Nitrogen
15x6	"	90	"	Phosphoric Acid
15x9	"	135	"	Potash

After that proceed as in former example:

Nitrogen	45x5	equal	225	lbs.	Sulphate of Ammonia
Phosphoric Acid	90x2½	"	225	"	Double Acid Phosphate
Potash	135x2	"	270	"	Muriate of Potash
			780	"	Filler
			1500	lbs.	

HOW TO CALCULATE THE PERCENTAGE

When the Weights of the Ingredients are Known.

Example—What is the percentage of nitrogen, phosphoric acid and potash in the following mixture?

1	sack	(200 lbs.)	Nitrate of Soda
1	"	(200 ")	Sulphate of Ammonia
2	"	400 "	Double Acid Phosphate
2	"	400 "	Sulphate of Potash
		1200 lbs.	

First find the weight of the nitrogen, phosphoric acid and potash in the mixture by dividing with the figures given in the table under "How to Calculate a Mixture."

Nitrate of Soda	200÷6¼	equal	32	lbs.	Nitrogen
Sulphate of Ammonia	200÷5	"	40	"	"
Double Acid Phosphate	400÷2½	"	160	"	Phosphoric Acid
Sulphate of Potash	400÷2	"	200	"	Potash

Again divide these figures by one hundredths of the weight of the mixture. The weight was 1200 lbs. therefore divide by 12, as follows:

Nitrogen	72÷12	equal	6%
Phosphoric Acid	160÷12	"	13.33%
Potash	200÷12	"	16.66%

This is an extremely high grade fertilizer, but by adding 800 lbs. filler the weight would be a ton, and for dividing, the figure 20 would have to be used instead of 12, in which case the result would be 3.6% nitrogen, 8% phosphoric acid and 10% potash, a mixture well suited for fruit and vegetables.

MATERIALS SUPPLYING PLANT FOODS.

The following materials are commonly used in the West Indies.

Potash	**Contains Potash**
Muriate of Potash	50.5 to 56%
Sulphate of Potash	48.6 to 52%
Kainit	12.4%

Phosphates	Contains Phosphoric Acid
Acid Phosphate	13 to 16%
*Double Acid Phosphate	28 to 44%
Basic Slag	20%
Tankage according to grade	5 to 10%

Nitrates	Contains Nitrogen
Sulphate of Ammonia	20%
Nitrate of Soda	16%
Dried Blood	12 to 14%
Tankage	5 to 10%

MANURES AND COMPOSTS.

All the waste animal and vegetable products on the plantation, and nearby towns or factories, are usually valuable for fertilizer, not alone on account of the plant food they contain, but also because of the organic matter which improves the texture and physical condition of the soil when applied in large quantities.

ANIMAL MANURES.

The amount of plant food contained in animal manures depends upon the class of animal, the kind of feed and the way the manure has been stored. Fresh horse manure

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N. B. Whenever the nitrogen content on the bag is stated as ammonia multiply the figures by 0.82 or divide by 1.21 in order to find out what the nitrogen content is.

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*The double Acid Phosphate in the formulas in this book is calculated to contain about 40%. When using a lower grade add 3 lbs. to every 100 lbs., for each per cent it is lower, viz: instead of using 100 lbs. of a 40%, use 114 of a 35%, or 130 lbs. of a 30% grade.

contains approximately in a ton 11.5 pounds nitrogen, 10.5 pounds potash and 5.50 pound phosphoric acid. At the present prices of mixed fertilizers in the West Indies, nitrogen is worth 24-34 cents per pound, potash 6-8 cents per pound and phosphoric acid 6-8 cents per pound. This would make the plant food in manure worth $3.72 to $5.19 per ton, but as stated above it is worth more than the actual value of the plant food it contains, and it is very important for every planter to guard against it being lost. If stable manure is piled in large quantities in a dry place it will dry ferment and loose nitrogen. If it is left to be dried out by the sun and washed out by the the rain it will loose all of the plant food.

An ideal way to keep manure is to compost it together with any other organic waste material from the farm. A good compost heap is made as follows:

HOW TO MAKE COMPOST.

Select a place near the barn with a surface which should be made sloping and impervious to water either by cement or hard packed clay. On the lower side of this construct a cement tank for the reception of the liquids draining from the manure. It is also desirable to have the compost pile protected from heavy rains, either by a covering of "yaguas" palm leaves, or some similar material or by a roofed shed which may be cheaply constructed.

The manure should be piled in alternate layers with dry grass, muck or even common earth, which will absorb the liquids and prevent the nitrogen from escaping. In the North, lime is sometimes added to hasten decomposition, but in this climate lime is not desirable as all organic materials decompose rapidly, and much of the valuable plant food, nitrogen, is lost by evaporation unless preserved in some manner.

Kainit and superphosphate are especially valuable absorbents and as both phosphate and potash are needed in stable manure, it has been found to be good economy to add these substances at the rate of 80 pounds kainit and 75 pounds superphosphate per ton of manure. If kainit cannot be had, use 20 pounds of high grade sulphate or muriate of potash. This will make the mixture contain 11 to 12 pounds nitrogen, 20 to 21 pounds potash and 16 to 17 pounds phosphoric acid per ton, a mixture well suited for either fruit or tobacco. When the pile becomes too dry it should be watered with the liquids from the tank and an additional amount of water to soak it through and wet it thoroughly and in a few months it will be rotted so that it can be easily spread, and ploughed under. The value of a well conserved compost containing potash and phosphoric acid is far greater than that of the average stable manure of the West Indies, which is seldom well conserved and which is always lacking in potash and usually in phosphoric acid.

GREEN MANURE.

Every planter recognizes that by plowing under a crop of grass he enriches his land. This however, is more apparent than real. The common wild grasses and even those usually found in cultivated fields, contain nothing more than what they derived from the soil in which they grew. Therefore by ploughing them under the soil will contain nothing more than it did. But it is of great advantage, nevertheless, because the plant food in the grass is in

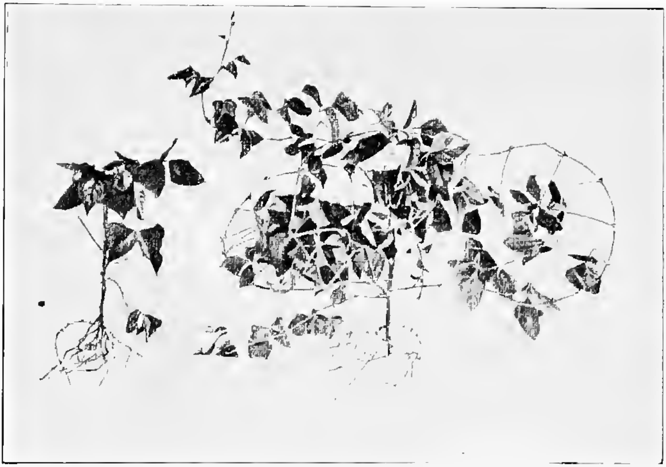
LAB-LAB BEANS AS COVER CROP. PLANTS 18 MONTHS OLD—CEIBA MOCHA, CUBA.

a much more available form than it was in the soil, and the next crop of plants will be able to utilize it almost at once. If this grass had been burned before ploughing under, only the one plant food, nitrogen, would have been lost, potash and phosphoric acid would have been left in the ashes, but as nitrogen is the most expensive of the three, grass should naturally not be burned. There are other reasons also why it should not be burned. Any organic matter decaying in the soil adds humus and improves the physical condition, which is often as essential as the plant food. But after all, the value of the crop of grass is not very great and it should always be the object to replace it with some more valuable plant.

The plants belonging to the family of legumes have this advantage over grass, that they are able to utilize and store up the nitrogen found in the air, and therefore by ploughing in a crop of these plants we add nitrogen to the soil, which is just as valuable as that for which we pay 20 to 30 cents per pound in commercial fertilizers.

There are many leguminous plants growing everywhere in the West Indies, and it is often more practicable to cultivate those indigenous to the locality than to import some from a distance. The ordinary native bean often grows much better than the cow pea of the Southern United States, and many native legumes are superior to the Florida beggarweed because they are acclimated. The chief requirement of a legume for green manure is that it must produce a large amount of material for ploughing under, because although some contain more nitrogen than others, the bulk usually determines the amount gained.

To give an idea of what such crops may produce we will examine the results of three experiments with velvet beans, conducted by the Agricultural Experiment Stations of Alabama, Louisiana and Florida, in which the average yield was 10.5 tons of green vines per acre, containing 167 pounds nitrogen, besides 8 pounds furnished by the roots left in the soil, total 175 pounds. If 160 pounds of this came from the air it would be a gain of $32.00 to $48.00 with nitrogen at 20 to 30 cents per pound. Experiments with cow peas at the Experiment Stations in Alabama, Arkansas, Connecticut, Louisiana, Rhode Island and South



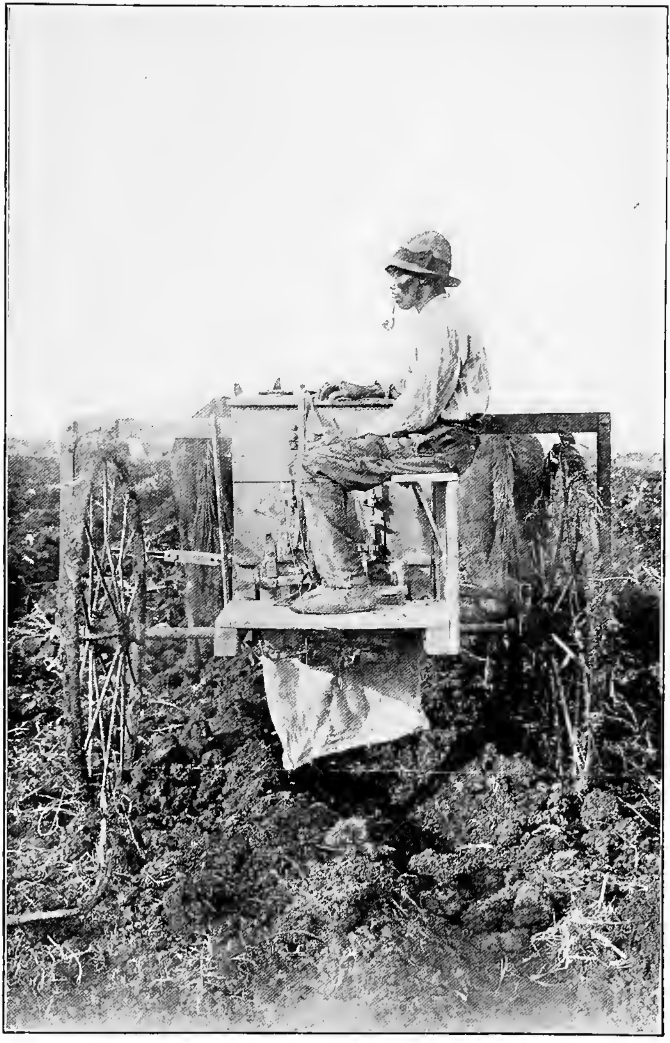
COW PEAS SHOWING NODULES ON ROOTS,, WHICH NODULES ARE THE HOMES OF MICROSCOPICALLY SMALL BACTERIA BY THE AID OF WHICH THE PLANTS ARE ENABLED TO UTILIZE THE NITROGEN IN THE AIR.
THE SMALL PLANT ON THE LEFT WAS NOT FERTILIZED WHILE THE ONE ON THE RIGHT RECEIVED POTASH AND PHOSPHORIC ACID.

Carolina showed an average yield with contents of 122 pounds of nitrogen, 29 pounds phosphoric acid and 122 pounds potash. At the Cuba Experiment Station, cow peas yielded over 15 tons of green matter, including the roots, which furnished 168 pounds nitrogen, 62 pounds phosphoric acid and 192 pounds potash. This all goes to show that with an application of 500 pounds acid phosphate and 400 pounds muriate or sulphate of potash, costing about $16.00, we would produce a fertilizer worth $45.00 to $55.00 and besides this greatly increase the humus content of our soils.

LIME.

The proper use of lime is of great importance in the West Indies. While lime is a plant food, it is seldom necessary to apply it as such, for most soils contain enough lime to support any vegetation. The chief function of lime is to correct soil acidity. Many West Indian soils are acid, and they are, for that reason unproductive. An acid soil cannot produce maximum yields of any of the crops grown in the West Indies. Leguminous plants, especially, will not grow in acid soil and the failure to produce good crops of green manure plants is often due to soil acidity.

Lime should seldom be applied in larger quantity than ½ ton per acre, but it may be necessary to repeat the dose every three to four years. Heavy clay soils, not very well drained, are liable to become acid. Also any soil on which large amounts of green vegetable matter is covered up every year; also soils, especially clay soils, on which acid fertilizers are being applied continually. Heavy cane soils on which sulphate of ammonia has been applied for years, are almost sure to be acid, and on many of such soils fertilizers are to-day being used at a loss.



DISTRIBUTING FERTILIZERS WITH MACHINE.

FERTILIZING.

Here are some of the questions which we are constantly asked:

Why is it necessary to fertilize?

Why is it that a soil will stop producing after a number of years and then again produce a few crops after having rested?

Why is it that this soil does not produce a good crop? I have had it analyzed and there seems to be enough plant food for several more crops.

What fertilizer is best for a certain crop?

How much fertilizer will it pay to use?

How and when should it be applied?

Most virgin soils contain a certain amount of plant food, part of which is available to the plants and some that is not. After clearing and planting such land, the available plant food will nourish the plants and more will gradually become available, but every crop removes a certain portion of nitrogen, potash and phosphoric acid, and after a time all that was available of one or more of these elements becomes exhausted and cultivation of that crop becomes unprofitable.

Now, on analyzing the soil, we may find that there is more plant food present which may further be proved by letting the land lay for some years without planting and then it will produce a few more crops. This is because the plant food left in the soil is so slowly available that it will not produce a crop, but after a few years the influence of the air, water and grass roots will have made enough of it available so that it is again profitable for planting. This shows that the result of a chemical analysis is not enough information for the planter. It also shows that although the land may not be able to produce another crop of the same particular kind it will produce grass and weeds.

Why is this?

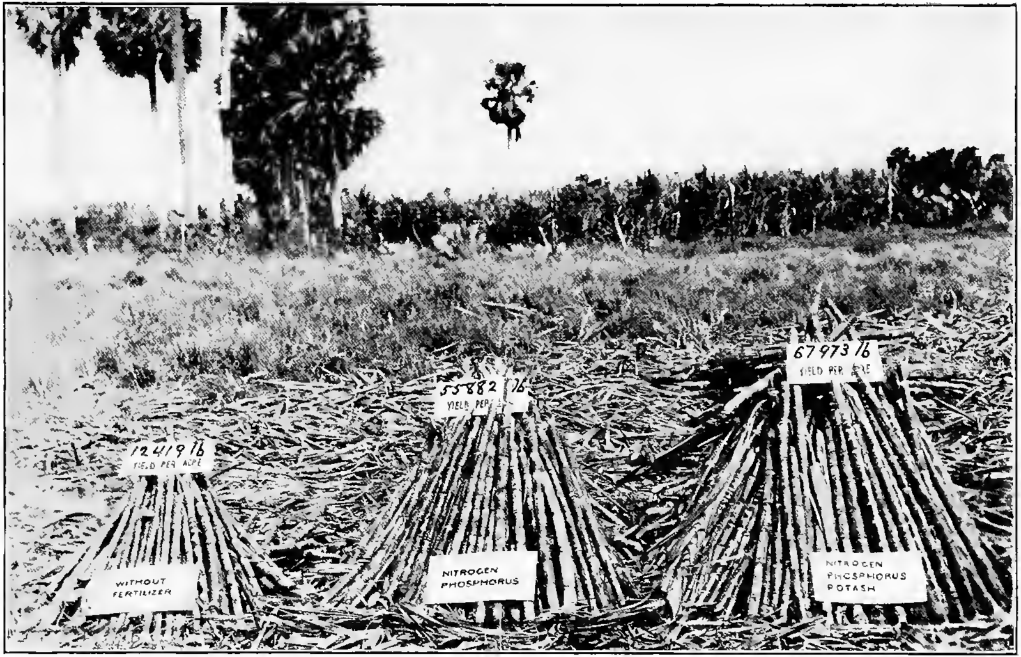
It is because certain plants require more of certain food elements than others, and while the previous crop may have nearly exhausted one of them, there may be enough left to sustain another crop. Also, some plants are able to utilize food from material which would not be available to other plants. For instance, a soil might not produce a good crop of casava, while it might still grow a crop of cane.

This is the principle underlying the methods of diversified farming as practised in the older agricultural countries. There the planter is gaining some of that slowly available plant food from nature's store-house every year by planting grain crops, root crops and leguminous crops in rotation and fertilizing according to the crop's need.

FIELD EXPERIMENTS.

In order to find out what plant foods our crops need, and in what form they must be applied, we must make practical experiments, because as previously explained a chemical analysis is not a sufficient guide.

For such an experiment, select a part of the field which has, as far as can be determined, the same kind of soil. It is also important to select it towards the middle of the field, or at any rate, not close to a road or ditch, where one of the plats would be subject to conditions more or less favorable than those of the others.



RESULT OF AN EXPERIMENT CONDUCTED IN COOPERATION WITH A. E. DOERING—MANACAS, CUBA.

The field should be measured off into plats, their size to be determined by the kind of crop planted. For experiments on cane, tobacco or cotton, 1/10 acre plats are suitable. For pineapples, 300 plants would be enough, and 1/20 acre is often all that is needed for vegetables. For fruit trees of any kind, 15 to 20 trees are usually enough. It is not difficult to measure off the plats, but it is often difficult to keep them separate when applying the fertilizer and when harvesting the crop. This difficulty can be overcome by stretching a wire around each separate plat.

The materials needed for the experiment should each contain only one of the plant food elements. For instance nitrogen can be supplied from nitrate of soda, sulphate of ammonia or dried blood, but not from tankage or cotton seed meal, because the last two contain other ingredients besides nitrogen. Phosphoric acid may be supplied in the form of acid phosphate or Thomas slag, and potash as sulphate or muriate.

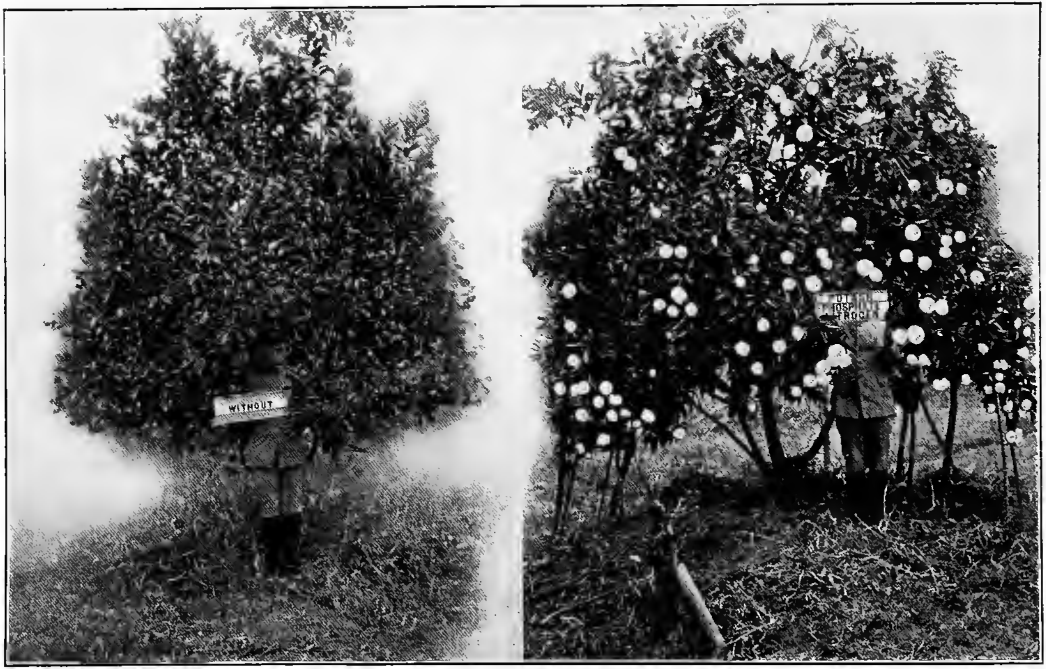
In the following experiment we find, not only the value of a complete fertilizer containing potash, nitrogen and phosphoric acid but also the value of mixtures in which one of these has been omitted. Comparing plot No. 2 with No. 1 we find that the complete formula gave an increase of 29.79 tons per acre and a profit of $104.65. On plot No. 3, where the nitrogen was omitted the yield was but 24.04 tons and the profit $91.78. On plot No. 4, without potash the yield was about the same as on No. 3, but the actual profit was less because nitrogen costs more than potash. Plot No. 5 without phosphoric acid yielded but 14.62 tons, and the profit was but $56.36.

Experiment With Sugar Cane, Conducted by J. Symes, San Marcos, Cuba.

RESULT OF SEASON 1911 AND 1912.

No. of Plat	No. of Acres per Plat	MANURING PER PLAT		MANURING PER ACRE		Cost of manuring per Acre Dollars	Yield per Plat lbs.	Yield per Acre lbs.	Increase per Acre over Unmanured lbs.	Value of Increase at current Market Rate Dollars	P per d Ma D
		Quantity lbs.	KIND	Quantity lbs.	KIND						
1	1/10		No Fertilizer		No Fertilizer		1256.7	12567			
2	1/10	23.7 9.5 43.3 11.4	Nitrate of Soda Sulphate of Ammonia Basic Slag Sulphate of Potash	237 95 433 114	Nitrate of Soda Sulphate of Ammonia Basic Slag Sulphate of Potash	20.47	7215	72150	59583 (29.79 tons)	125.12	10
3	1/10	43.3 11.4	Basic Slag Sulphate of Potash	433 114	Basic Slag Sulphate of Potash	9.23	6066.6	60666	48099 (24.04 tons)	101.01	9
4	1/10	23.7 9.5 43.3	Nitrate of Soda Sulphate of Ammonia Basic Slag	237 95 433	Nitrate of Soda Sulphate of Ammonia Basic Slag	16.65	6153.4	61534	48967 (24.48 tons)	102.82	8
5	1/10	23.7 9.5 11.4	Nitrate of Soda Sulphate of Ammonia Sulphate of Potash	237 95 114	Nitrate of Soda Sulphate of Ammonia Sulphate of Potash	15.06	4181.6	41816	29249 (14.62 tons)	61.42	56.36

Remarks:—Soil sandy loam, underlayed with yellow sandy clay. Drainage good.
Manure applied April 1911. Crop harvested February 1912. Cane sold for $4.20 per 2000 lbs.



EXPERIMENT ON CITRUS TREES CONDUCTED ON LA PUERTA ESTATE, TRINIDAD (SEASON 1912).

The general conclusions to be drawn from this experiment are:

(1) A complete fertilizer is, not alone needed, but also very profitable.

(2) In this soil phosphoric acid is very much needed but it will not be liable to increase the yield very much without being applied together with potash and nitrogen.

If a planter knows or thinks that his soil needs two, of the plant-foods, but he is in doubt about the third one a simple experiment like the following will give the information.

EXPERIMENT ON SUGAR CANE,
Conducted by Casas & Sardinas, Calimeta, Cuba.

Manuring per Plat	Cost of Manure Per Acre	Yield Per Acre 16.99 Tons	Increase Per Acre Over Unmanured	Value of Increase at Current Market Rate	Profit Per Acre Due to Manuring
Nothing		16.99			
502 lbs. Dried Blood 155 " Double Acid Phosphate 144 " Sul. Potash	$24.34	43.26	26.27 tons	$65.67	$41.33
502 lbs. Dried Blood 155 " Double Acid Phosphate	$19.55	38.46	21.47 tons	$53.67	$34.12

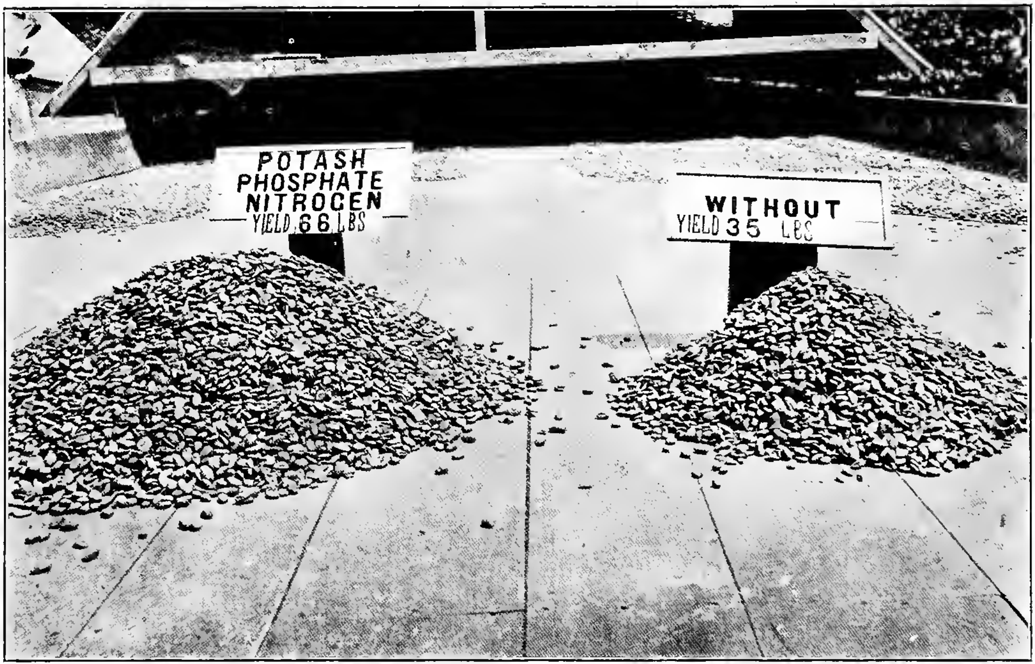
Remarks: Soil red clay underlaid with coral lime stone. Drainage good. Manure applied Nov. 1912. Crop harvested Nov. 1913 Cane sold for $2.50 per ton.

In the district where this experiment was conducted fertilizer mixtures containing little or no potash, were frequently applied. The results obtained show clearly however, that potash is needed and that when used it gives a good return for the money invested.

HOW MUCH FERTILIZER TO USE.

Sometimes the question arises how much fertilizer of a certain kind will it pay to use? This can of course be settled by fertilizing several plats with increasing amounts and comparing the yields. This was done by the Artemisa Tobacco Co. in reference to potash with the result that 510 lbs. sulphate of potash per acre in addition to horse manure, gave much better results than 340 lbs. under the same conditions and also a better profit than 680 lbs. Showing that from 500 to 600 lbs. sulphate of potash per acre is a better investment on that soil and under those conditions than larger and smaller quantities.

Plant food is of no value unless the soil and climatic conditions are favorable for plant growth. A soil that is well cultivated and contains enough moisture to produce 100 tons of cane per acre should certainly be fertilized so as to produce that amount. On the other hand if it is in poor physical condition and does not contain moisture for more than 30 tons, it will not pay to apply more fertilizer than the amount required to produce 30 tons of cane. We should also consider that in order to calculate profit and loss, from the application of a fertilizer, the plant food in that fertilizer must be in such form that the plants can utilize it at the time it is needed. It must be in such form that it is not lost before the plants absorb it and the three elements must be in the proportion in which they are needed by the plants. That is to say, it would be useless to expect paying results from a fertilizer containing nitrogen in a slowly soluble form applied to a quick growing crop in a dry location. It would be equally wasteful to apply a salt



YIELDS OF DRY BEANS OBTAINED IN AN EXPERIMENT WITH CACAO ON LA PUERTA ESTATE, TRINIDAD (SEASON 1912).

like nitrate of soda in large quantities on a slow growing crop in localities with heavy rainfall. Therefore, a fertilizer should always be made of materials suitable to the conditions and the crop for which it is intended.

The price of the product grown is an important consideration in fertilizing. A fertilizer may give a substantial increase in yield, and yet it may not be profitable. For instance in sugar cane, an increase of ten tons per acre would be considered very good in most places. But supposing that the price of cane were but $2.00 per ton the total increase would be but $20.00. It is obvious that in such a case the extra ten tons of cane would have to be produced by a fertilizer costing not more than $15.00, or else there would be no profit, after paying for the labor, interest, etc.

While such conditions, as in the aforementioned example may exist, the general rule is that fertilizing is the most profitable investment in agriculture. Intensive farming, such as that of the older agricultural countries in Europe was originally built up by a very liberal use of stable manure and during the last decade it has been maintained by the additional use of commercial fertilizers. In America the whole agricultural prosperity of certain communities rests on commercial fertilizers and without exception we find that as agriculture becomes more intensive the use of fertilizers becomes more extensive.

HOW TO FERTILIZE.

SUGAR CANE.

Experiments during the last few years have demonstrated that it is seldom as profitable to apply potash and phosphate in two applications as in one. Of nitrogen it usually pays to make two applications, and by using readily soluble salts, in moist climate, it may be profitable to apply the nitrogen in three doses; but as a general rule, no fertilizers of any kind should be applied within three to four months of harvesting the cane.

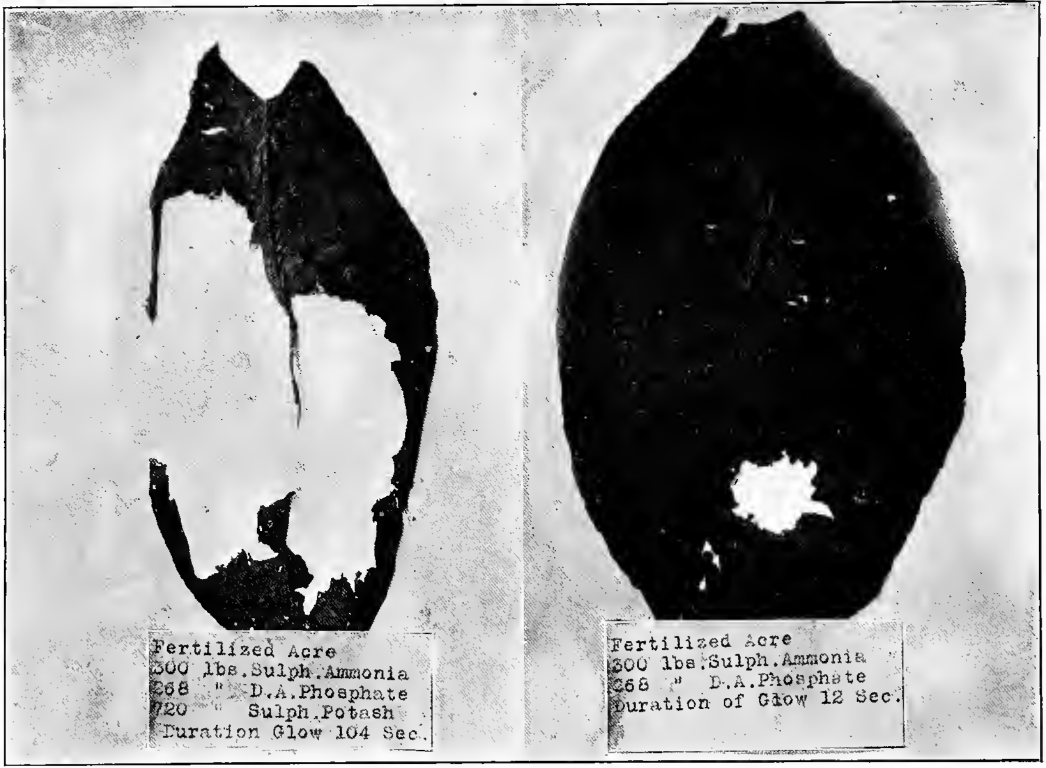
It is good policy to mix the potash and the phosphate together with part of the nitrogen and apply this mixture, in the furrow or in the hill, according to the system of planting. The application is usually made immediately before planting, and it is important to mix the fertilizers well with the soil before planting the cane. The rest of the nitrogen may be applied three to four months later or in two applications, which is seldom necessary nor profitable.

Rattoon cane should be fertilized as soon as practicable after the cane has been harvested. One of the best methods is to move the trash from each alternate middle over onto the next one; then apply the fertilizer in the cleared middle and work it in with a fork or with a horse-drawn implement.

According to experimental data, obtained from government experiment station reports, the following amounts of plant foods should be profitable in the West Indies:

PURE CHEMICALS PER ACRE.

ISLAND	POTASH.	PHOSPHORIC ACID.	NITROGEN.
Cuba	50 lbs.	80 lbs.	40 lbs.
Porto Rico	60 "	80 "	60 "
Jamaica	25 "	60 "	20 "
Barbados	80 "	? "	60 "
Trinidad	50 "	40 "	40 "



AVERAGE RESULT OF ABOUT A HUNDRED BURNING TESTS CONDUCTED WITH CUBAN TOBACCO GROWN ON FIELDS WITH AND WITHOUT POTASH.

These chemicals may be obtained from any of the materials from which fertilizers are made, and in order to find out how much to use of each one refer to the table on page 21.

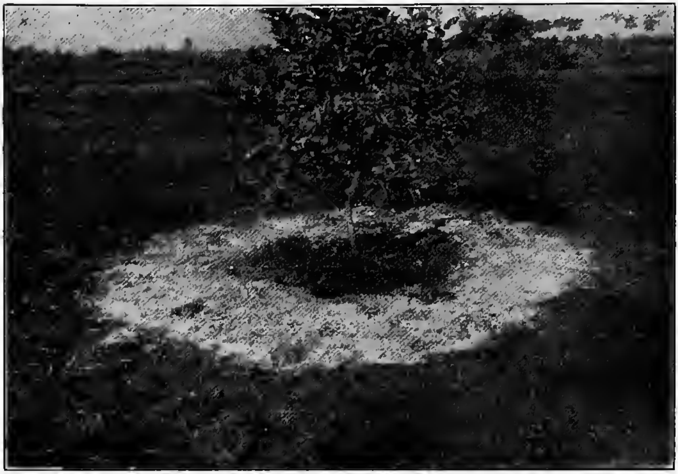
TOBACCO.

There are two stages at which tobacco must be fertilized, one is the seed-bed and the other the field.

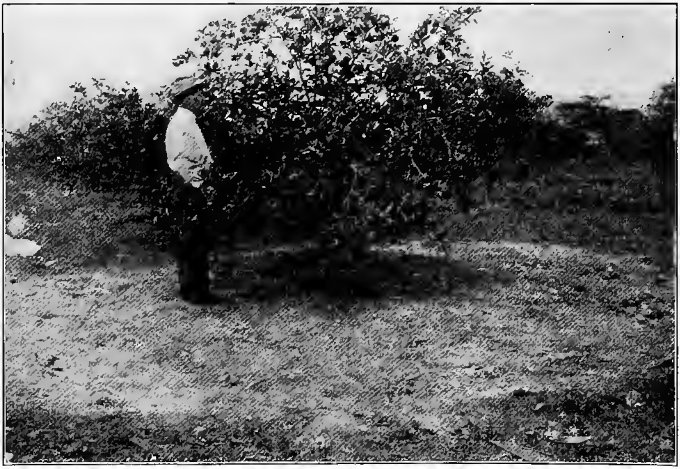
The seed-bed should be especially well prepared. The clods should be pulverized and all trash should, either be well buried, or else raked off. In order to insure a good stand of plants the seed-bed should be fertilized with a half ton to one ton per acre of a mixture containing 8% potash, 8% phosphoric acid and 4% nitrogen.

Before the plants are ready to be transferred from the seed-bed, the field should be ready to receive them. The fertilizer should always be applied before the plants are set. Where the cultivation is intensive and where large amounts of fertilizers are used it is good policy to spread it broadcast and harrow it in. Where one half ton or less is applied per acre it must be spread in the furrow. For that purpose furrows should be made in the planting rows with a plough. The fertilizer should be scattered in those furrows at the rate of 75 lbs. per 1000 plants and mixed with the soil, by running a cultivator or some other toothed instrument back and forth; after which the plants may be set.

A fertilizer for a high grade wrapper and filler should contain about 3½% nitrogen, 6% phosphoric acid and 10% to 12% potash. A cheap grade of tobacco used for filler in cheaper cigars or for other purposes may be fertilized



FERTILIZING CITRUS TREES SHOWING THE PROPER DISTANCE AT WHICH TO FERTILIZE A ONE YEAR OLD TREE.



FERTILIZING CITRUS TREES SHOWING THE PROPER DISTANCE FROM TRUNK AT WHICH A FIVE YEAR OLD TREE SHOLD BE FERTILIZED.

with a mixture containing about 3% nitrogen, 7% to 8% phosphoric acid and 9% potash.

Where stable manure is used an extra application of sulphate of potash should always be given. 200 lbs. per acre will, almost without fail, be profitable and frequently as much as 500 lbs. will be required in order to obtain maximum results.

FRUIT TREES.

In fertilizing fruit trees the size and the age of the tree should always be considered. When a tree is first set out it has but few roots and it must take up its nourishment from a limited space around the trunk. By fertilizing in the planting holes and mixing the fertilizer well with the soil, a good feeding ground is provided and if other conditions are favorable the growth will be rapid. As the top develops, the roots develop in equal proportion and it is obvious that in a year from planting the feeding roots are not close to the trunk. Therefore it is wrong to apply fertilizers close to the trunk of a growing tree. As the tree grows larger the feeding roots will be found farther and farther away from the trunk and naturally the fertilizer will have to be applied so as to be within reach of the roots. It should also be considered that the roots are not confined to a narrow circle around the tree and the fertilizer must be well scattered in order to be of benefit to all the roots.

GOOD FERTILIZERS FOR DIFFERENT CROPS.

BANANAS.

Mix the following materials and apply ½ lb. of the mixture at planting time. 1 lb. 4 months after and ¾ lb. before blooming.

30	lbs.	Sulphate or Muriate of Potash.
30	"	Double Acid Phosphate.
* 40	"	Sulphate of Ammonia.
100	"	Sand or dry earth.

CACAO.

Of the following mixture apply 3 to 6 lbs. per tree to prolific trees and correspondingly less to poor trees.

35	lbs.	Sulphate or Muriate of Potash.
40	"	Double Acid Phosphate.
40	"	Sulphate of Ammonia.
85	"	Sand or dry earth.

CITRUS FRUITS.

Of the following mixture apply 15 to 30 lbs. per tree to bearing trees.

48	lbs.	Sulphate of Potash.
30	"	Double Acid Phosphate.
30	"	Sulphate of Ammonia.
92	"	Sand or dry earth.

---

* In this as well as the following mixtures Sulphate of Ammonia has been given for uniformity's sake. In most cases Nitrate of Soda or Dried Blood, wholly or partly, would be as desirable and in some cases even more so. By using either of these materials take of Nitrate of Soda 6¼ lbs. or of 14% Dried Blood 7½ lbs. to replace each 5 lbs. Sulphate of Ammonia.

COCONUTS.

Apply six lbs. or more to each bearing tree per year of the following mixture.

40 lbs.	Muriate of Potash.
40 "	Double Acid Phosphate,
40 "	Sulphate of Ammonia.
80 "	Sand or dry earth.

COFFEE.

Of the following mixture apply 2 or 3 lbs. to each bearing tree.

20 lbs.	Sulphate or Muriate of Potash.
20 "	Double Acid Phosphate.
30 "	Sulphate of Ammonia.
30 "	Sand or dry earth.

COTTON.

The following mixture should be applied per acre:

100 lbs.	Muriate of Potash.
200 "	Double Acid Phosphate.
100 "	Sulphate of Ammonia.
100 "	Sand or dry earth.

CANE.

The two mixtures here given are good average compositions. The first one for Cuban heavy soil and the second for Trinidad.

The following amounts to one acre:

100 lbs.	Sulphate of Potash.
200 "	Double Acid Phosphate.
200 "	Sulphate of Ammonia.

100 lbs.	Sulphate of Potash.
100 “	Double Acid Phosphate.
200 “	Sulphate of Ammonia.

PINEAPPLES.

The following is a good mixture for fruit production. Apply to 1000 plants (1 oz. per plant).

20 lbs.	Sulphate of Potash.
8 “	Double Acid Phosphate.
14 “	Dried Blood.
21 “	Dry earth.

ROOT CROPS.

To the average root crop apply 1 lb. of the following mixture in a length of 3 to 5 yards of furrow before planting.

12 lbs.	Sulphate of Potash.
10 “	Double Acid Phosphate.
10 “	Sulphate of Ammonia.
18 “	Sand or dry earth.

TOBACCO.

For 1000 plants apply 50 to 75 lbs. of the following mixture in the furrows before planting.

200 lbs.	Sulphate of Potash.
150 “	Double Acid Phosphate.
150 “	Sulphate of Ammonia.
500 “	Sand or dry earth.